

**A NEW TRIAL OF MONITORING SALMON MIGRATORY
BEHAVIOR BY AN AUTOMATIC TRACKING ROBOT BOAT**

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There are mainly three different instruments to monitor underwater fish movement. The first is ultrasonic or radio active transmitters that emit pulsed or coded signals detected in real time. They can directly track and monitor fish movement and do not necessarily need to be recovered, but they are very labor intensive since researchers must be constantly engaged in receiving signals, and remote detection is possible only in fixed station. The second is archival tags or micro-datalogger: that can store various data to be recovered at a later time. They can store data, including ambient temperature, swimming depth, swimming speed, heart rate, and brain waves without constant monitoring, but they must be recovered before the data can be downloaded. The third is passive integrated transponder tags that are monitored by hand or stationary detectors. They can be implanted into a great number of fish at low cost, but they never reveal fish behavior and the fish must be very close to the detector for monitoring.

Since each technique has great advantages and/or minor disadvantages in clarifying physiological mechanisms of fish behavior, ten experts in the fields of ship engineering, signal processing, acoustic engineering, and computer science have carried out a collaborative research project to develop an automatic salmon-tracking robot boat in Lake Toya since 1999. In order to monitor lacustrine salmon (sockeye salmon, masu salmon, and rainbow trout) homing migration for several days in the lake the following interrelated four equipment systems have been developed; 1) a robot boat, 2.5 m in length, 1.3 m in width, with a loading capacity of 120 kg, operating by two electric thrusters at 2 knots, 2) an ultrasonic tracking system detecting distance and direction of miniature pingers, 3) a signal processing and control system consisting of DGPS, acoustic signal, and gyroscope, 4) a telecommunication system between a land base and the boat.

Using a NTT handy-phone circuit, we have already succeeded in navigating

the boat to any point in the lake using commands from shore, in having the boat cruise and stop by self-navigation, and in transmitting data from the DGPS and gyroscope from the boat to the base. And, we have just succeeded in tracking lacustrine sockeye salmon homing behavior by the robot boat at a distance of 100 m on October 2001. In the near future, we are planning to track salmon using the robot boat from the Bering Sea to Hokkaido.



Fig. A SWATH type robot boat with styrofoam twin hull constructed by pipes, operating two electric thrusters. This boat is easy to disassemble, construct, and carry to anywhere in the world.